

Application No.: 10/087,069

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**Amendments to the Specification:**

Please replace paragraph [0028] with the following amended paragraph:

[0028] The invention includes a method and a system for creating and using a data store of profile-based simulation information. Figures 2 and 3 illustrate the differences between simulation profiles versus actual profiles of structures. Figures 4 to ~~8C~~ 8B depict embodiments of the creation process for the profile-based simulation data store. Figure 9A and 9B depict embodiments for using the profile-based simulation information. Figure 10 illustrates one format of the simulation data store, while figures 11A and 11B represents empirical data that illustrate the utility of the concepts and principles of the present invention.

Please replace paragraph [0032] with the following amended paragraph:

[0032] FIG. 4 is an architectural diagram illustrating the use of an optical metrology system to determine the profile of periodic structures. The optical metrology system 40 includes a metrology signal source 41 projecting a signal 43 at the target periodic structure 53 of a wafer 47 mounted on a metrology platform 55. The metrology signal 43 is projected at an incidence angle  $\theta$  towards the target periodic structure 53. The reflected signal 49 is measured by a metrology signal receiver 51. The reflected signal data 57 is transmitted to a metrology profiler system 59. The metrology profiler system 59 compares the measured reflected signal data 57 against a library of calculated reflected signal data representing varying combinations of critical dimensions of the target periodic structure and resolution. The library instance best matching the measured reflected signal data 57 is selected. The profile and associated critical dimensions of the selected library instance correspond to the cross-sectional profile and critical dimensions of the features of the target periodic structure 53. A similar optical metrology system 40 is described in co-pending U.S. patent application Ser. No. 09/727,530 entitled "System and Method for Real-Time Library Generation of Grating Profiles" by Jakatdar, et al., filed on November 28, 2000, which issued as U.S. Patent No. 6,768,983 on January 27, 2004, owned by the assignee of this application and incorporated herein by reference.

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Please replace paragraph [0033] with the following amended paragraph:

[0033] FIG. 5A is an architectural diagram illustrating the creation of a simulation data store using a device simulator in one embodiment of the present invention. The profile-based creation of a simulation data store 100 includes a fabrication process designer 101 where the series of IC fabrication steps are laid out. A set of test grating masks is designed in the test grating mask designer 103 to capture key features or characteristics of the area of interest. For example, if the area of interest is capacitance of interconnects, then the set of test grating masks designed captures the various interconnect geometric information. Interconnect geometric information include profiles of structures in the wafer. The IC fabricator 105 uses the set of test grating masks to make test structures that are measured by a metrology device 107. The metrology device 107, which may be an optical metrology device or a non-optical metrology device, measures the signals off the test gratings and transmits the measured signals to the profiler application server 109. The profiler application server 109 compares the measured signals off the test structures to the calculated signals in a profile library 110 covering a range of expected structures profile critical dimensions and resolutions. The profiler application server 109 selects the best matching profile library instance from the calculated signals of the profile library 110. In one embodiment, the best matching measured diffracted metrology signal is one with the least error compared to the diffracted metrology signal. Several optimization procedures are available to minimize the error, such as simulated annealing, described in "Numerical Recipes," section 10.9, Press, Flannery, Teukolsky & Vetterling, Cambridge University Press, 1986; which is incorporated by reference. One error metric that produces appropriate results is the sum-of-the-squared-difference error, where the optimization procedure minimizes the error metric between the measured diffracted metrology signal and the calculated diffracted metrology signal. The detailed procedure for creating calculated signals for a profile library for a range of structure profile critical dimensions and resolutions and selecting the best matching library instance from the calculated signals library is contained in co-pending U.S. patent application Ser. No. 09/727,530 entitled "System and Method for Real-Time Library Generation of Grating Profiles" by Jakatdar, et al., filed on November 28, 2000, which issued as U.S. Patent No. 6,768,983 on January 27, 2004, and is incorporated herein in its entirety by reference.

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Please replace paragraph [0035] with the following amended paragraph:

[0035] FIG. 5B is an architectural diagram illustrating the creation of an interconnect simulation data store in one embodiment of the present invention. The profile-based creation of a simulation data store 120 includes a fabrication process designer 121 where the series of IC interconnects are laid out. A set of test grating masks is designed in the test grating mask designer 123 that captures the various interconnect geometric information. Interconnect geometric information include profiles of structures in the wafer. The IC fabricator 125 uses the set of test grating masks to make test structures that are measured by a metrology device 127. The metrology device 127, which may be a reflectometer, an ellipsometer or other non-optical metrology device, measures the diffracted signals off the test structures and transmits the measured signals to the profiler application server 129. The profiler application server 129 compares the measured signals off the test structures to the calculated signals in a library 130 covering a range of expected structures profile critical dimensions and resolutions. The profiler application server 129 selects the best matching library instance from the library. The profile CD's of the best matching library instance is extracted by the profiler application server 129 and transmitted to the interconnect simulator 133. The interconnect simulator 133 creates as output the set of process control parameters used in the simulation run and the device attributes. Examples of interconnect simulators include Raphael.TM, QuickCap.TM, and Atlas.TM. The output of the interconnect simulator 133 includes device attributes such as resistance in ohms, capacitance in farads, and inductance in henrys. The simulation data store generator 131 creates a data store instance in the simulation data store 135 for each test grating comprising signals, profile data, simulation type, and device attributes. Simulation type is in this case is interconnect device simulation and the device attributes are those associated with the interconnect device simulation. An illustrative layout of simulation data store is depicted in FIG. 10.

Please replace paragraph [0037] with the following amended paragraph:

[0037] Still referring to FIG. 6A, from the fabrication attributes 134, the metrology simulator 137 extracts the profile data and calculates signals corresponding to the signals off a grating with

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the transmitted profile shape and CD's. In a case where the metrology simulator 137 is an optical metrology simulator, the signals are simulated diffraction signals. For a description of the calculation of simulated diffraction signals, refer to co-pending U.S. patent application Ser. No. 09/764,780 entitled "Caching of Intra-Layer Calculations for Rapid Rigorous Coupled-Wave Analyses" by Jakatdar, et al., filed on January 26, 2000, which has been expressly abandoned, which is incorporated in its entirety herein by reference. The simulation data store generator 139 processes the process control parameters 132 and input data from the fabrication process simulator 133 and the metrology simulator 137 to create the simulation data store 149 instances. The simulation data store instance comprises signals, profile data, simulation type, process control parameters, and fabrication attributes associated with the process simulation. Simulation type is the characterization of the simulation being performed, for this example, fabrication process simulation. A partial list of simulation types is included in FIG.10.

Please replace paragraph [0043] with the following amended paragraph:

[0043] FIG. 7A is an architectural diagram illustrating inquiry and in-line use of a simulation data store in one embodiment of the present invention. An inquiry 203 from an inquiry device 201 is transmitted to a simulation data store server 207 that analyzes the inquiry and accesses the instance(s) of the simulation data store 215 and formulates the response 205. The simulation data store server 207 may also be invoked by an in-line query 209 generating a response ~~209~~ 213. In one application, the inquiry 209 is from an in-line query device 211 generating a response 213. The inquiry 209 comprises the type of inquiry and query given data. Depending on the type of inquiry and query given data, the simulation data store server 207 retrieves the appropriate instance(s) of the simulation data store 215 and formats and transmits the response 213. The in-line query device 211 may be part of a computer system or part of an IC fabrication system. The inquiry device 201 may be a stand-alone device or part of a system. Furthermore, the inquiry device 201 may be local or accessible through a network.

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Please replace paragraph [0045] with the following amended paragraph:

[0045] FIG. 8A is a flow chart of the operational steps for creation of a profile-based simulation data store using profile library data in one embodiment of the present invention. The expected profile data ranges and resolutions of profile shapes of patterned structures for the profile library are determined 300. For example, a trapezoidal profile shape may be characterized by the top CD, bottom CD, grating thickness, height and width at the inflection point, and underlying thickness in nanometers. The profile data ranges would include a minimum, maximum, and resolution for the top CD, bottom CD, grating thickness, height and so on. The profile data ranges at various resolutions of profile shapes are used to calculate the simulated diffracted signals and to create the profile library 320. The detailed procedure for creating a profile library for a range of structure profile critical dimensions and resolutions is contained in co-pending U.S. patent application Ser. No. 09/727,530 entitled "System and Method for Real-Time Library Generation of Grating Profiles" by Jakatdar, et al., filed on November 28, 2000, which issued as U.S. Patent No. 6,768,983 on January 27, 2004, which is incorporated herein in its entirety by reference.

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Please replace the Abstract with the following amended Abstract:

~~The invention includes a method and a system~~ An exemplary method and system for generating integrated circuit (IC) simulation information regarding the effect of design and fabrication process decisions. ~~One embodiment includes creating and using a data store of profile-based information comprising metrology signal, structure profile data, process control parameters, and IC simulation attributes.~~

~~Another embodiment is a~~ An exemplary method and system for generating a simulation data store using signals off test gratings that model the effect of an IC design and/or fabrication process. ~~One application includes creation and use of~~ includes creating and using a simulation data store generated using test gratings that model the geometries of the IC interconnects. The interconnect simulation data store may be used in-line for monitoring electrical and thermal properties of an IC device during fabrication. Other embodiments include ~~methods and systems for generating and using simulation data stores~~ utilizing a metrology simulator and various combinations of a fabrication process simulator, a device simulator, and/or circuit simulator. ~~Information from the simulation data store may be used in-line in situ during the design or fabrication process steps.~~

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